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The Relative Contribution of Cognitive and Physical Components in Volleyball Injuries Prediction

Parvaneh Hesami [1], Ramin Balouchy [1, *] and Mohammadreza Ghasemian [1, **]

[1] Faculty of Physical Education and Sport Sciences, Allameh Tabataba'i University, Tehran, Iran

[*] *Corresponding author*: Associate Professor, Faculty of Physical Education and Sport Sciences, Allameh Tabataba'i University, Tehran, Iran. Email: ram_b81@yahoo.com
[**] *Corresponding author*: Assistant Professor, Faculty of Physical Education and Sport Sciences, Allameh Tabataba'i University, Tehran, Iran. Email: mor.ghasemian@atu.ac.ir

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Abstract

Background: Researchers have always sought to investigate the factors affecting sports injuries in order to identify ways of preventing and controlling such factors. These studies have more emphasis on physical aspects, while the cognitive and psychological components may also be effective.
Objectives: The present study was conducted to answer the question whether or not injury can be predicted in volleyball athletes through physical and cognitive components.
Methods: For this purpose, 50 volleyball players with the age range of 18 to 25 years old participated in the study. The subjects were evaluated using Barratt impulsiveness scale, Functional movement screen and continuous performance test (for sustained attention). Then, the injuries occurrence were recorded. Furthermore, logistic regression test was run to predict injury in athletes and the bi-serial correlation coefficient was used to investigate the relationship between the factors.
Results: The findings showed that there was a significant negative correlation between functional movement screen scores and injuries occurrence. There was also a significant positive correlation between omission and commission errors and injury occurrence, meaning that alongside the increase in the omission and commission errors, the injury occurrence increased; however, there was no significant relationship between the scores of Barratt impulsiveness scale and the injury occurrence.
Conclusions: The findings of this study showed that mental and cognitive components, along with the physical factor, play a significant role in injury occurrence in volleyball players, so it is better to consider it in prevention and rehabilitation programs.

Keywords: Attention, Impulsivity, Functional Movement Screen, Sport Injuries

1. Background

Researchers have always sought to investigate the factors affecting sports injuries in order to identify ways of preventing and controlling such factors. In this regard, numerous factors have been mentioned for the occurrence of sports injuries, some of which have been emphasized on physical aspects, while others, such as the movement patterns, as well as techniques, have focused on the skill aspects of injury (1). In this regard, functional movement screen (FMS) is one of the characteristics that has been studied in the field of sport injury (2). Research has shown that this scale, in addition to assessing the quality of performing functional patterns, identifies individuals at risk. Studies that have examined the relationship between FMS and the occurrence of injury, present the scores of this test as a predictor of injury (1, 3, 4). On the other hand, in the study of factors affecting the prediction of injuries, more emphasis has been placed on physical and skill aspects, while sport performance is multidimensional (5, 6). Consequently, as physical and skill components can be effective in predicting injury, mental and psychological components may also be effective (7, 8). Previous research has focused on the role of characteristics such as reaction to stress, coping with stress, personality traits, anxiety, and other emotional components, and to a lesser extent its underlying influential mechanisms (9).

One of the features that can be considered in the prediction of athletic injury along with physical and skill components is the processing characteristics of individuals or their cognitive abilities (10). In this respect, the role of neurocognitive features such as attention and concentration of athletes and the type of information processing and the type of decision making by athletes have been less widely considered. This is while sports environment is full of events that the athlete has to decide on and react (6). One of the components that is evaluated in this area is im-

pulsivity. Impulsivity is a kind of action without consideration or behavior without any appropriate evaluation of the consequences (11). Impulsivity is considered a personality trait in some perspectives (12), while others view it as related to information processing style (13). The results of research on sports have shown that the skill level and even the type of sport can affect impulsivity (14). In addition to the impulsive personality trait, cognitive components involved in information processing can also play a major role in athletic performance (6). In this category, the term used in the literature is called executive functions. Executive functions cover a wide range of top-down processes such as inhibition, attention, working memory and planning (15). One of the important dimensions of executive functions is inhibition and maintaining attention that underpins the maintenance of many functions (15). Inhibition control includes the ability to ignore (or inhibit attention to) particular stimuli and attend to others based on our goal or intention (15). Hence, people with higher levels of attention and inhibition can be less likely to be injured. Although the cognitive components seem very important in predicting the occurrence of sports injuries, little research has been done in this regard, and that previous research has merely examined the relationship between these components and sport performance. Wilkerson (16) showed that the reaction time as a neurocognitive function, predicted the extent of the injury to the strain and the sprain on the lower limb of the soccer players. Williams and Anderson (17) showed that when academic athletes were stressed when responding to visual stimuli, they had a more peripheral vision and had a slower reaction time. On the other hand, the follow-up research showed that the number of injuries that occur in athletes is related to this reduction in peripheral vision in conditions of stress and negative events (18). Shibata et al. (5) showed that in athletes with lower neurocognitive performance, an increase in quadriceps muscle activity than hamstring in this unexpected landing was observed; this superiority of quadriceps increases the pressure on the ACL and increases the risk of injury. As a result, people with lower neurocognitive performance are more likely to be affected by ACL due to impaired motor activity around the knee (14).

In both above mentioned studies, the reaction time as a neurocognitive characteristic was used. Although reaction time in literature is considered as the speed of information processing and is an important component in this area, there are higher cognitive components that are related to the accuracy of decision-making. Accordingly, decision errors can be a predictive factor in the inappropriate performance timing, which both of them, along with the lack of caution, may cause injury. As a consequence, the continuation of research with different neurocognitive components seems logical. In addition, due to limited research in this area, it is quintessential to expand and test it in different sports disciplines with different processing demands. On the other hand, previous research has been more of one-dimensional studies which had evaluated one of these features.

2. Objectives

The present research seeks to investigate the simultaneous relationship between skill, personality, and cognitive components and the onset of injury of athletes. Accordingly, this question arises as whether or not it is possible to predict the occurrence of sports injuries by combining these components.

3. Methods

The present study is a descriptive correlational research in terms of study design. A total of 50 volleyball players aged 18 to 25 years old at the national league level were selected. At the first day, demographic and personal health information of participants were obtained. The subjects were assured that the data would remain confidential, and that the subject could leave the research without any specific explanation at any time if they were not willing to cooperate and continue to work. Then informed written consent was obtained for all participants. Furthermore, Barratt impulsiveness scale, continuous performance test, and FMS were evaluated. Then the injuries that occurred during the champion season (16 weeks) was recorded by fitness trainer. The sport injuries occurrence defined as injuries that occurred during the competitions season (in matches or training sessions) and needed the medical attention, and that limited participation to the train or matches for at least one day after its occurrence.

3.1. Functional Movement Screen

The functional movement screen test based on Cook and colleagues (2, 19) were used. Each subject was evaluated based on its performance in seven functional movements. Movements scored from 0 to 3 according to the quality of execution and the specified instruction. Each test is done 3 times and the total score is 21.

3.2. Barratt Impulsiveness Scale

In this research, the Barrett impulsivity scale, eleventh edition, was used. The questionnaire encompasses 30 items, each of which on a scale of four-point Likert scale from never (score 1) to always (score 4) (20). Javid et al. (21) confirmed the validity and reliability of this version in Iranian population.

3.3. Continuous Performance Test

Sustained attention was examined by the continuous visual performance test. In the test, there were 200 stimulants that were divided into two categories, the first was the stimulus that individuals would have to respond to by pressing a key on the computer keyboard. Failure to respond to these stimulants was considered to be an omission error. On the other hand, the individuals were provided with the stimuli not to respond to. Responses to this type of stimuli were considered as a commission error. The arrangement of the stimulus was random and people were unaware of the process of providing stimuli (22).

3.4. Statistical Analysis

Descriptive statistics, bi-serial correlation coefficient and logistic regression was run to statistical analysis. Based on the injuries record forms the athletes were classified to injury occurrence and non-occurrence groups.

4. Results

The Table 1 show the demographic measures of participants, as shown 26% of participants have experienced injures occurrence during the champion season (16 weeks), of which 28.5% suffered lower extremity injuries and 28.5% suffered upper limb injuries and 23% had injuries in other part like back and lumbar. As shown in Table 2, the injured group had a lower mean FMS score, and higher number of omission and commission errors, mean reaction time as well as response time variability. In addition, the overall score of Barratt scale was also higher in this group.

Table 1. Demographic Measures of Participants

Components	Groups	
	With Injury Occurrence	Without Injury Occurrence
Percent of total participants	26	74
Age	21.9	21.8
Height	165.59	168.11
Weight	61	67

The results of the bi-serial correlation test showed that there was a significant negative correlation between FMS test scores and injury occurrence during the season (r = -0.353, P = 0.01). Moreover, the results showed that there was no significant relationship between Barratt scale scores and injury occurrence during the season (r = 0.19, P = 0.18).

Table 2. Descriptive Measures of Variables

Components	Groups	
	With Injury Occurrence	Without Injury Occurrence
FMS	13.61	15.83
Omission errors	6.03	3.05
Commission errors	3.71	1.68
Reaction time	357.23	344.37
Reaction time variability	108.61	91.94
Barratt scale	68.23	63.43

On the other hand, although there was no significant relationship between reaction time (r = 0.07, P = 0.64) and reaction time variability (r = 0.2, P = 0.16) with injury occurrence, there was a significant positive correlation between omission (r = 0.396, P = 0.004) and commission errors (r = 0.341, P = 0.015) and injury occurrence.

In order to predict the occurrence of injury, based on the combination of physical and cognitive components, the logistic regression analysis was used. First, the sequence of omission and commission error variables, reaction time, reaction time variability, Barratt impulsivity score, and FMS were defined as a predictor variable and the injury occurrence as a dependent variable. The dependent variable has two levels: occurrence or non-occurrence of injury during the season. However, in the final model, only the FMS variable and omission error remained as the predictors ($P < 0.05$). The Hosmer-Lemeshow test was used for model fit. The results showed that this test was not significant ($\chi^2 = 2.7$, $P = 0.95$). This result indicates that the model was suitable. Then, the results of the chi-square test showed that the regression model was significantly reliable ($\chi^2 = 13.19$, $P = 0.001$). The model predicted 23 to 34 percent of the variance in injury (Cox-Snell $R^2 = 0.232$, Nagelkerke $R^2 = 0.34$); however, the remaining variance was influenced by other factors. The Table 3 shows the coefficients and statistics for each of the predictor variables, according to which only the variables of FMS and the omission error could predict the variables.

5. Discussion

The purpose of this study was to investigate the relationship between the FMS test as a motor skill component, the attention test as a cognitive component and impulsivity as a personality trait and the occurrence of injury. The results showed that there was a significant negative relationship between the FMS scores and injury incidence. This result was consistent with the results of the

Table 3. Logistic Regression Coefficients

Predictor	β	SE β	Wald's χ^2	df	P
Constant	2.29	2.12	1.17	1	0.28
Omission error	0.268	0.12	5.7	1	0.017
FMS	-0.314	0.14	4.6	1	0.031

study by Kiesel et al. (1) and O'Connor et al. (23), which indicated that there is a relationship between the scores of the FMS and the occurrence of injury. On the basis of this, it seems that athletes with ineffective motor patterns are more likely to expose to sport injuries. In this regard, since functional screen movement test provides valuable information about stability and mobility, these two components play an important role in the occurrence of injuries, thus, it can play a role in the prevalence of injuries. In this regard, Kiesel et al. (3) showed that the use of prevention training in people with a lower rating in the functional screen test reduces the likelihood of injury.

On the other hand, results showed that, there was no significant relationship between Barratt impulsiveness scale and injury incidence. As mentioned, impulsivity is a kind of action or behavior without consideration, which does not have an appropriate evaluation of its consequences (11). Hence, it seemed that there was a relationship between this component and the occurrence of injury; however, such relationship was not observed. This result may be related to the nature of volleyball. The volleyball is a non-contact sport meaning people are not allowed to kick or push the other player. The role of impulsivity in injuries occurrence in contact sports should be studied. As mentioned above, in the sub-components of the attention test, the results showed that there was a significant relationship between the omission and commission errors and the occurrence of sport injury. Accordingly, in order to properly process information and make effective decisions, an individual must be able to maintain his attention during the task and avoid diverting attention from other irrelevant stimulus. This result is consistent with the results of the studies by Wilkerson (16) and Shibata et al. (5) where there were differences in neurocognitive characteristics associated with injury, although there were differences in the details of the results. Wilkerson (16) indicated that the amount of time needed to perceive stimuli was needed and the speed of processing information was related to environmental awareness and the prompt response of athletes to environmental changes and external forces. Shibata et al. (5) also showed that cognitive function is related to the kinetic and kinematic characteristics associated with injury. Accordingly, people with lower neurocognitive performance are more likely to suffer from ACL due to ineffective muscle activity around the knee (5). The results of the study by Swanik et al. (10) showed that processing speed and visual verbal memory were lower in those who had a history of non-contact ACL injury. As a result, neurocognitive functions can be considered as a risk factor. Olsen and colleagues (24), in addition, found that during the moment of ACL injury, athletes' attention was directed toward the opponent, or things like the choice of the next task. As a result, athletes with weaker neurocognitive functioning may perform movements such as a sudden change in the point of landing or unexpected movements that can potentially harm them.

The findings on the prediction of injury showed that along with FMS, only omission error remained in the model. Accordingly, the ability to maintain attention over time along with physical or motor variables seems to be an important factor in predicting sports injuries. The results of this study can be viewed from the point of view of individual differences. According to previous research, there is a difference between people according to the level of attention (25). Hence, people with different levels of attention can be exposed to the different probability of sport injuries occurrence. However, this component alongside FMS predicts only a part of variation of the occurrence of injury and the remainder is predicted by other factors. Therefore, future research should examine other components, and given the totally different nature of sports tasks, implementing such research in different sports and levels of skill seems quintessential.

5.1. Conclusions

In general, the findings showed that both cognitive and physical components are important factors in determining the incidence of injury in female volleyball players. However, it should be noted that taking into account the complex nature of sport, prediction based on a single component does not provide a comprehensive conclusion. Accordingly, this research can be considered a preliminary study in the field of prediction of the occurrence of sport injuries based on cognitive characteristics in general and the component of sustained attention in particular.

Footnotes

Authors' Contribution: All the authors contributed to developing the protocol, analyzing the data, and preparing the manuscript.

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